ECODESIGN OF TRANSFORMERS IN EU

Revision of the European Commission's Ecodesign Regulation Tier 2 loss requirements became effective on July 1, 2021

INTRODUCTION

The long-term efforts of the European Union to reduce transformer losses and emissions of transformers leading to decarbonization of our planet were completed in May 2014 with the publication of Commission Regulation (EU) No. 548/2014 on implementing Directive 2009/125/ES of the European Parliament and of the Council concerning Ecodesign requirements on distribution and power transformers. Since November 2019, new Regulation 2019/1783 replaces 584/2014 Regulation. The EU Ecodesign regulation for transformer losses Tier 2 will take effect from 1st July 2021 replacing Tier 1 regulation. Since 1st July 2021, in EU, small, medium and large power transformers must meet the requirements of Tier 2 losses.

PURPOSE

Using more energy efficient transformers should lead to energy savings of an estimated 16 TWh per year after 2020. This is equivalent to 3.7 million tons less of CO_2 being emitted each year, or half of Denmark's total annual electricity consumption (32 TWh).

TRANSFORMERS LOSSES AND EFFICIENCY

Distribution transformers itself are device with high level of efficiency, when transmitting an electric power. Efficiency can be calculated as:
η=output power/(input power +no load loses+load loses)
Specially for distribution transformers, we have to calculate with All day efficiency, because secondary supply mostly in residential areas at night represents only core loses because there is very low consumption. Then:

$$\textit{All day efficiency} = \frac{\textit{output (in kWh per 24 hours)}}{\textit{input (in kWh per 24 hours)}}$$

Effective reduction of transformer losses and fulfilling Ecodesign requirements at the same time can be done by improving the quality of the steel used for magnetic circuit (reduction of no-load losses) and increasing the cross section of the electrical conductors of the winding (reduction of load loses).

Transformer losses are represented by two types:

1) Winding losses

Winding loses are caused by the resistance of the copper or aluminum winding. With increasing current in the winding due to increasing load, the greater are the winding losses and thus produced heat.

2) Core losses

Core losses can be described by two phenomena. First one is the eddy-current loss, which are caused by the formation of eddy-current in the core material itself. The second one is related to hysteresis loss influenced by the behavior of magnetic field in the core. Bothe loses produces heat in the transformer. By the proper lamination of the magnetic core and proper materials with optimal hysteresis curve can reduce the losses

ECODESIGN REQUIREMENTS

Table I.1: Maximum load and no-load losses (in W) for three-phase liquid-immersed medium power transformers with one winding with Um ≤ 24 kV and the other one with Um ≤ 1,1 kV

Tier 1 (from 1 July 2015)		Tier 2 (from 1 July 2021)		
Rated Power (kVA)	Maximum load losses Pk (W) (1)	Maximum no-load losses Po (W) (1)	Maximum load losses Pk (W) (1)	Maximum no-load losses Po (W) (1)
≤ 25	C_k (900)	A_o (70)	A_k (600)	A_o – 10 % (63)
50	C_k (1 100)	A_o (90)	A_k (750)	A_o – 10 % (81)
100	C_k (1 750)	A_o (145)	A_k (1 250)	A_o – 10 % (130)
160	C_k (2 350)	A_o (210)	A_k (1 750)	A_o – 10 % (189)
250	C_k (3 250)	A_o (300)	A_k (2 350)	A_o – 10 % (270)
315	C_k (3 900)	A_o (360)	A_k (2 800)	A_o – 10 % (324)
400	C_k (4 600)	A_o (430)	A_k (3 250)	A_o – 10 % (387)
500	C_k (5 500)	A_o (510)	A_k (3 900)	A_o – 10 % (459)
630	C_k (6 500)	A_o (600)	A_k (4 600)	A_o – 10 % (540)
800	C_k (8 400)	A_o (650)	A_k (6 000)	A_o – 10 % (585)
1 000	C_k (10 500)	A_o (770)	A_k (7 600)	A_o – 10 % (693)
1 250	B_k (11 000)	A_o (950)	A_k (9 500)	A_o – 10 % (855)
1 600	B_k (14 000)	A_o (1 200)	A_k (12 000)	A_o – 10 % (1080)
2 000	B_k (18 000)	A_o (1 450)	A_k (15 000)	A_o – 10 % (1 305)
2 500	B_k (22 000)	A_o (1 750)	A_k (18 500)	A_o – 10 % (1 575)
3 150	B_k (27 500)	A_o (2 200)	A_k (23 000)	A_o – 10 % (1 980)

Table I.2: Maximum load and no-load losses (in W) for three –phase dry-type medium power transformers with one winding with Um ≤ 24 kV and the other one with Um ≤ 1,1 kV.

Tier 1 (1 July 2015)		Tier 2 (1 July 2021)		
Rated Power (kVA)	Maximum load losses Pk (W) (2)	Maximum no-load losses Po (W) (2)	Maximum load losses Pk (W) (2)	Maximum no-load losses Po (W) (2)
≤ 50	B_k (1 700)	A_o (200)	A_k (1 500)	Ao – 10 % (180)
100	B_k (2 050)	A_o (280)	A_k (1 800)	A_o – 10 % (252)
160	B_k (2 900)	A_o (400)	A_k (2 600)	A_o – 10 % (360)
250	B_k (3 800)	A_o (520)	A_k (3 400)	A_o – 10 % (468)
400	B_k (5 500)	A_o (750)	A_k (4 500)	A_o – 10 % (675)
630	B_k (7 600)	A_o (1 100)	A_k (7 100)	A_o – 10 % (990)
800	A_k (8 000)	A_o (1 300)	A_k (8 000)	A_o – 10 % (1 170)
1 000	A_k (9 000)	A_o (1 550)	A_k (9 000)	A_o – 10 % (1 395)
1 250	A_k (11 000)	A_o (1 800)	A_k (11 000)	A_o – 10 % (1 620)
1 600	A_k (13 000)	A_o (2 200)	A_k (13 000)	A_o – 10 % (1 980)
2 000	A_k (16 000)	A_o (2 600)	A_k (16 000)	A_o – 10 % (2 340)
2 500	A_k (19 000)	A_o (3 100)	A_k (19 000)	A_o – 10 % (2 790)
3 150	A_k (22 000)	A_o (3 800)	A_k (22 000)	A_o – 10 % (3 420)

Table I.3: Maximum load and no-load losses (in W) for medium power liquid immersed pole-mounted transformers

Tier 1 (1 July 2015)		**Tier 2 (1 July 2021)**		
Rated Power (kVA)	Maximum load losses (in W) (3)	Maximum no-load losses (in W) (3)	Maximum load losses (in W) (3)	Maximum no-load losses (in W) (3)
25	C_k (900)	A_o (70)	Bk (725)	A_o (70)
50	C_k (1 100)	A_o (90)	Bk (875)	A_o (90)
100	C_k (1 750)	A_o (145)	Bk (1 475)	A_o (145)
160	C_k + 32 % (3 102)	C_o (300)	C_k + 32 % (3 102)	C_o – 10 % (270)
200	C_k (2 750)	C_o (356)	B_k (2 333)	B_o (310)
250	C_k (3 250)	C_o (425)	B_k (2 750)	B_o (360)
315	C_k (3 900)	C_o (520)	B_k (3 250)	B_o (440)
1 250	A_k (11 000)	A_o (1 800)	A_k (11 000)	A_o – 10 % (1 620)
1 600	A_k (13 000)	A_o (2 200)	A_k (13 000)	A_o – 10 % (1 980)
2 000	A_k (16 000)	A_o (2 600)	A_k (16 000)	A_o – 10 % (2 340)
2 500	A_k (19 000)	A_o (3 100)	A_k (19 000)	A_o – 10 % (2 790)
3 150	A_k (22 000)	A_o (3 800)	A_k (22 000)	A_o – 10 % (3 420)

SUMMARY

Two stages:

- Tier 1 effective from 1st July 2015
- Tier 2 effective from 1st July 2021

Since 1st July 2021, Manufacturers and Importers of transformers can't sell Tier 1 Transformers and lower (except for limited exceptions).
Maximum level of loses is given by EU regulation.
Refurbished and repaired transformers requiring a replacement of a damaged component without a drastic change to the transformer's performance, type or purpose are not considered new products and thus, do not have to comply with Tier 2 requirements.